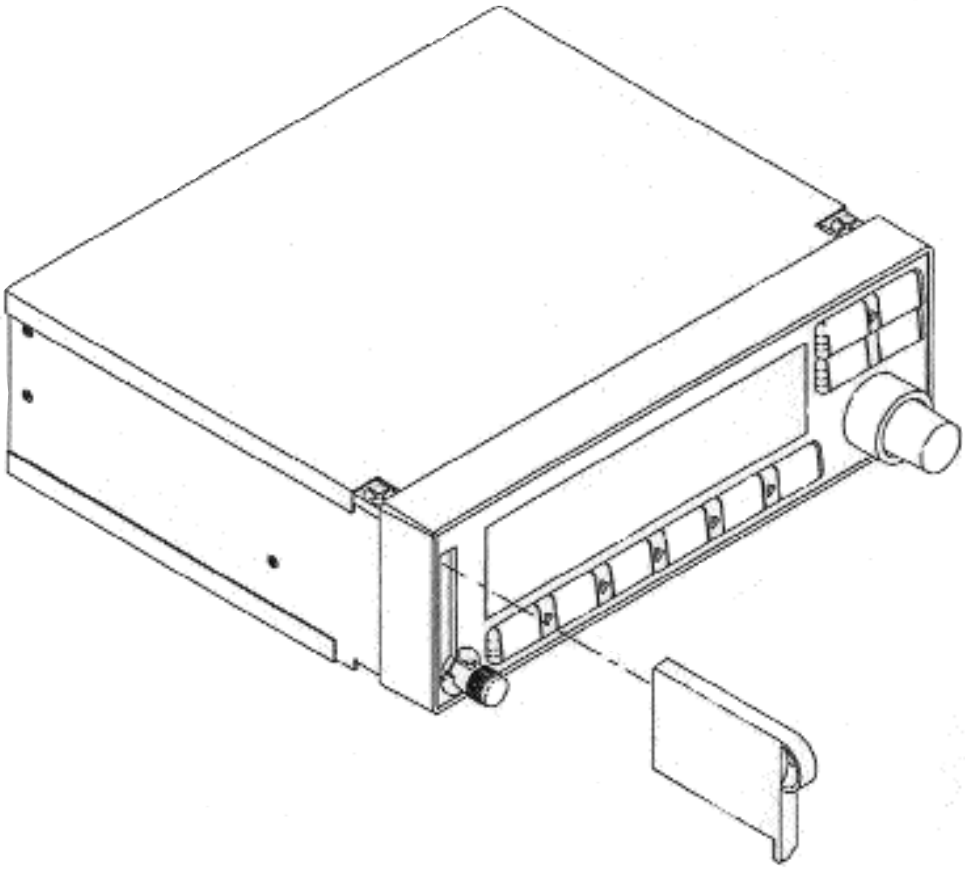
GPS 155
MAINTENANCE AND REPAIR MANUAL



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SECTION 1
INTRODUCTION

This manual is intended to provide instructions and guidelines for the maintenance and repair of the GARMIN GPS 155.

WARNING: This unit contains static sensitive devices. Service personnel must insure that proper precautions are taken to prevent damage to this equipment from Electro-Static Discharge (ESD). Disassembly and repair should only be accomplished in an approved ESD workstation by properly trained and grounded personnel.

1.1 GENERAL DESCRIPTION

The GPS 155 is a full-featured aviation GPS navigation instrument that offers not only a fixed panel mounted installation in its rack, but also provides a take-home capability. The GPS 155 utilizes the patented GARMIN Multitrac™ system for tracking up to eight satellites simultaneously. The unit features a GPS receiver; a front loading NavData card; and a sealed rechargable battery pack. The unit is constructed from high quality materials and uses the latest techniques in manufacturing technology.

In order to achieve the desired reliability, size and power requirements, surface mount components are used extensively. Specialized equipment and procedures are required to repair circuit boards having surface-mounted components. GARMIN does not authorize the repair of GPS 155 circuit boards. All circuit boards and assemblies for the GPS 155 can be economically replaced if necessary.

The following modules and printed circuit board assemblies are available for field replacement:

Display Board Assembly:
Contains the vacuum fluorescent display and display circuit board.

Rotary Switch Assembly:
Contains dual concentric switch and its assembled wiring harness.

Control/Display Unit:
Contains bezel, buttons, lens, keypad board, light pipes, front insert, plus the Display Board Assembly and Rotary Switch Assembly.

Main Board:
Printed circuit board which contains the microprocessor, LSI, power supply circuitry, and battery charging components.

Altitude Decoder Board:
Printed circuit board which contains the altitude data decoder circuits and interface circuitry.

Interface Board:
Printed circuit board which connects the main board to the NavData® card and the Altitude Decoder Board.

RF/IF Assembly:
Module which contains the GPS receiver and high precision crystal oscillator.

External Battery Pack:
Sealed package containing rechargable cells, fuse and wiring harness.

1.2 DETAILED DESCRIPTION

Internally, the GPS 155 is divided into six printed circuit boards: the main, RF/IF, altitude decoder, interface, display, and keypad circuit boards. The block diagram in Figure 1 below shows the interrelationships between major circuits and modules within the GPS 155.

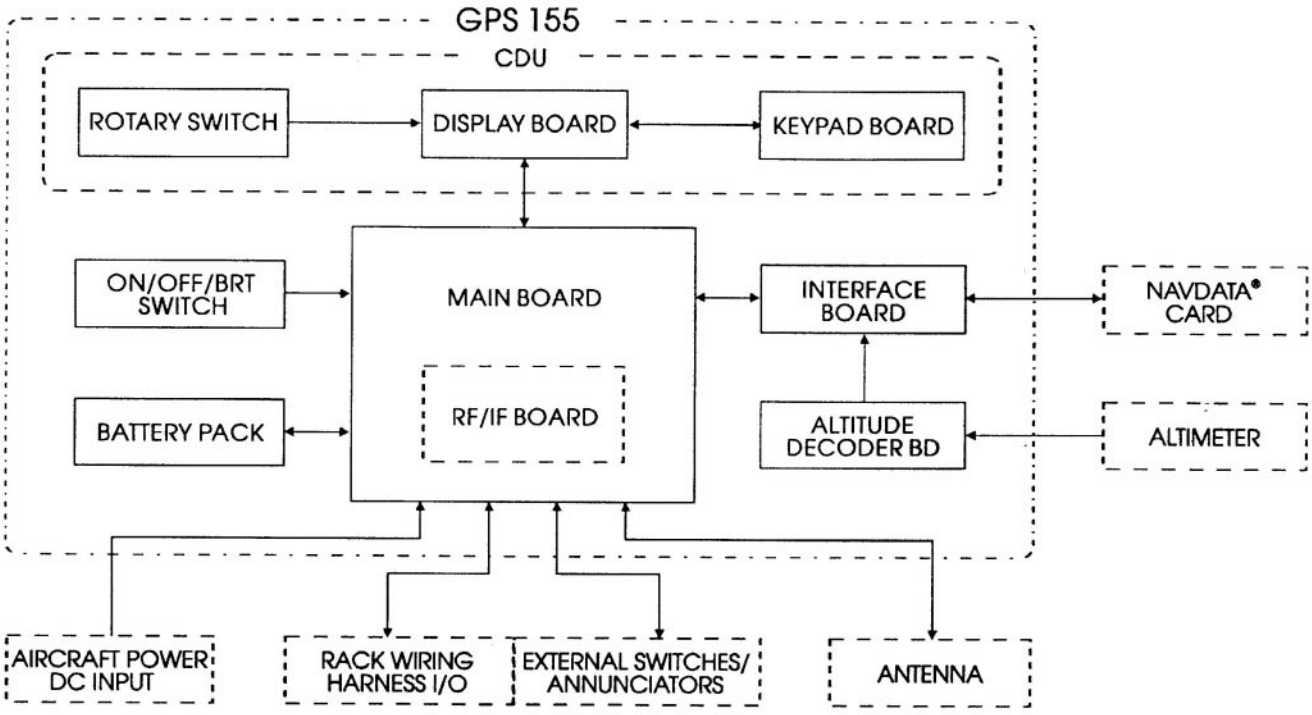


Figure 1
GPS 155 Block Diagram

1.2.1 Control/Display Unit (CDU)

The Control/Display Unit is an assembly consisting of ten keycaps, keypad board, light pipes optical lens, front insert panel, vacuum fluorescent display (VFD) and board with drivers, display board shock mounting grommets and screws, housed in a die cast bezel with a dual concentric rotary switch and two knobs. The VFD is a 3 row by 20 column unit with variable intensity. This display provides excellent day and night visibility from wide viewing angles. The front panel provides function selection and alphanumeric input to the Main Board Assembly via 10 push-buttons and the dual concentric rotary knob. There are two LEDs behind each keycap, providing backlighting for night time use.

The block diagram in Figure 2 shows the interaction between components on the Control/Display Unit.

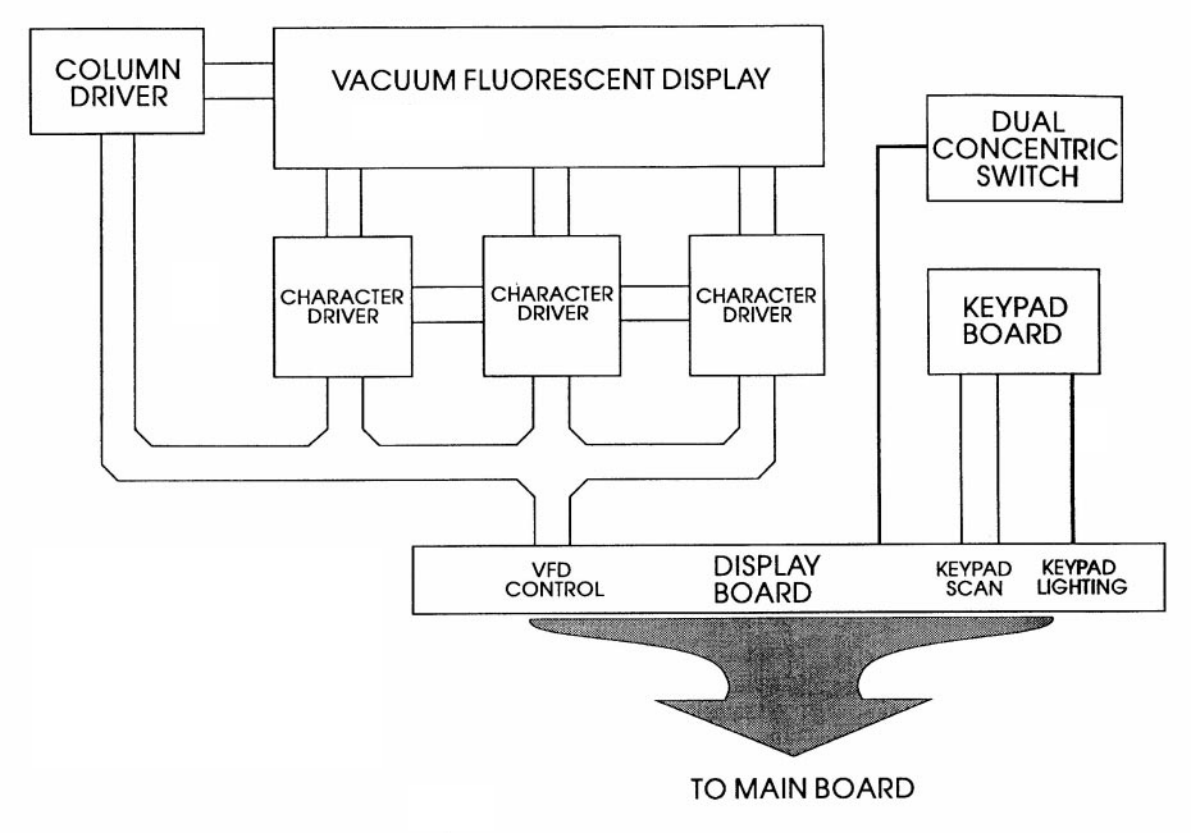


Figure 2
Control/Display Unit Block Diagram

1.2.2 Main Board Assembly

The Main Board Assembly contains the CPU, operating system ROM, system memory, discrete I/O, serial communication drivers/receivers and the power supply. These items are discussed in further detail below.

1.2.2.1 Central Processing Unit (CPU)

The Main Board is a microprocessor-based computer board. This board contains an Intel 80L186EB microprocessor running at 16 MHz, a plug-in read only memory chip (ROM) and random access memory chips (RAM). Data stored in RAM is maintained by a 3 volt lithium battery when the unit is switched off, and by the regulated 5 volt supply when the unit is powered on. A custom LSI is used to decode the signals from the GPS satellites. A real time clock IC is used to keep track of the date and time. Other circuits on the board are used for input/output functions such as controlling the display, reading the keypad, and controlling the receiver. Discrete input/output lines are provided for CDI course deviation, CDI to/from flag, CDI NAV flag, Super Flag, external annunciators, OBS course, and to activate the Approach mode. Serial communication lines for OBI (clock/data/sync), ARINC 429, RS-422 and RS-232 (two channels) are also included.

The block diagram in Figure 3 below shows the interaction between the various Main Board circuits.

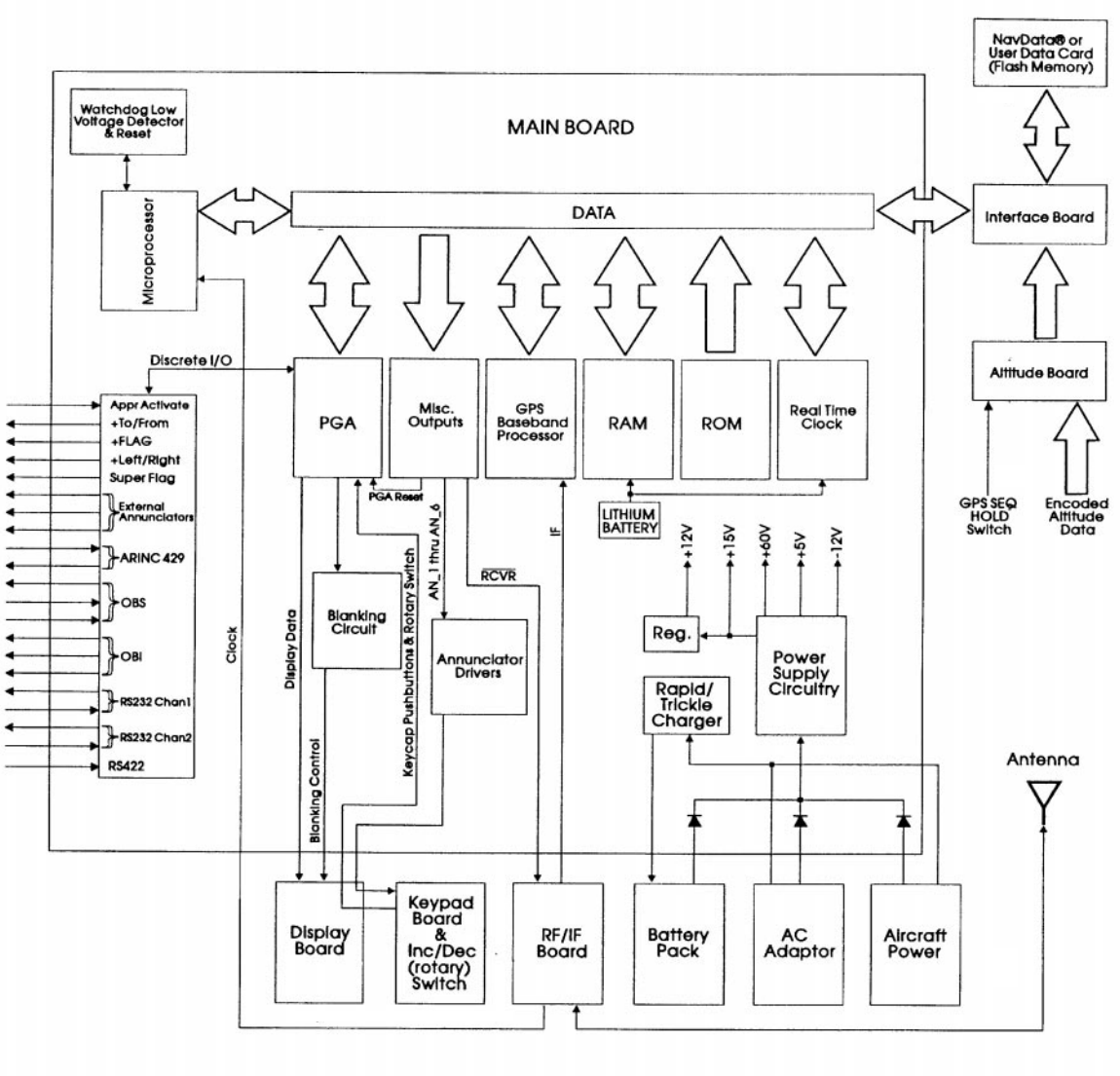


Figure 3
Main Board Block Diagram

1.2.2.2 Power Supply Circuits

The power supply section of the Main Board supplies +60 volts for the display drivers, ±12 volts, +15 volts, +5 volts (VCC), on/off circuits, and the battery charger. In addition, the main board contains comparator circuits for detecting low NiCad battery level, low memory battery voltage, and external power.

The external power input is through the rear connector (J101, Figure 5) and from the AC adapter through a DC power jack located near the rear connector. Both of these sources as well as the battery input are diode isolated to prevent parallel sourcing. The unit is turned on and off by a digital latch circuit operated by a knob located on the front panel adjacent to the NavData® card opening. The switching circuit is a fly-back design. The switching regulator operates at a frequency of approximately 40 KHz and uses a high efficiency switching regulator for the switching device. The high efficiency switching regulator drives a transformer that is configured in a fly-back mode. The +15 volt output is post-regulated to provide 11.75 to 12.25 volts. The +5 volt output is regulated at 4.8 to 5.2 volts. All other voltages are ±20%.

The NiCad battery charger circuit is built around the Integrated Circuit Systems, Inc. ICS1700A rapid charge controller. This controller uses a pulsed charging system, which is in effect when external power is supplied through the rear connector. When the unit is off, the batteries are not being charged by the external supply. When the unit is connected to a wall charger, however, the batteries are trickle charged at a constant current of 125 mA.

1.2.3 RF/IF Assembly

The RF/IF assembly consists of a dual conversion receiver, a frequency synthesizer, and a high precision crystal oscillator. The receiver consists of a ceramic RF filter, RF and IF amplifiers, mixers, and an IF filter. The frequency synthesizer uses the high precision oscillator as a reference frequency for the phase detector in the synthesizer. The resultant frequency is used in the mixer section to produce the first IF. After further amplification and mixing with a product of the crystal oscillator, the baseband IF is passed to the CPU Board for processing. The crystal output is also used for the system clock pulse. The RF/IF assembly is contained within a shielding fence/cover and connection to the antenna is made via a BNC connector. The RF/IF supplies +5 volts to the antenna's preamplifier through this BNC connector.

The block diagram in Figure 4 below shows the interaction between components on the RF/IF Assembly.

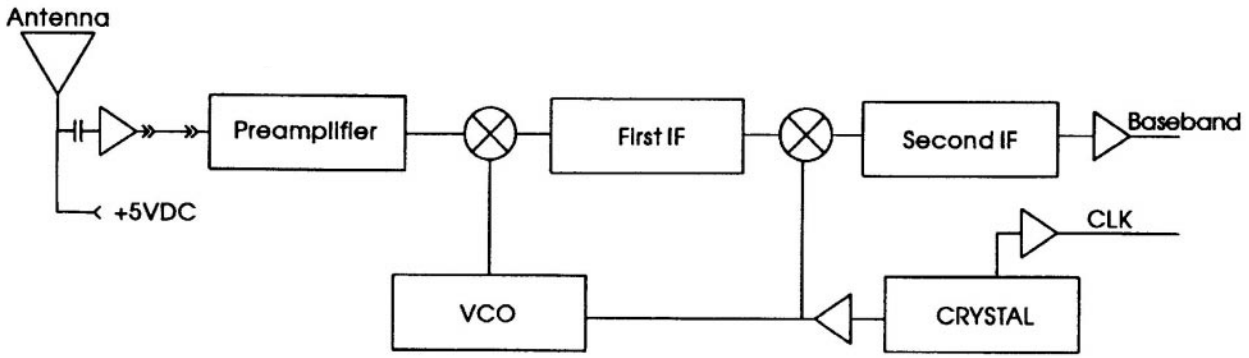


Figure 4
RF/IF Block Diagram

1.2.4 Interface Board and Data Cards

The Interface Board provides two-way data transfer capability between the Main Board and a data card. NavData® cards, available in sizes from 1 to 4 megabytes depending on the content/coverage area, allow for data transfer to the Main Board only. User data cards, with 768 kilobytes of flash memory data storage, may be used to save user data/settings from the GPS 155 or restore that information to the GPS 155. Address and data lines from the Main Board route through the Interface Board's output buffers to the data card. A plastic race secures the Interface Board at the front of the unit and serves to guide the data card onto the 40-pin connector.

NOTE: When servicing the GPS 155, user-defined waypoints, routes, settings, etc., may be saved on a user data card (010-10032-03) first. In the event these data are lost, they may then be restored from the user data card before the unit is returned to service. Refer to Appendix A of the GPS 155 Pilot's Guide for additional information on user data card operation.

1.2.5 Altitude Decoder Board

The Altitude Decoder Board contains the 26-pin rear connector (J2), discrete/parallel inputs and Gillham/Greycode decoder circuitry. Encoded pressure altitude data from a parallel altimeter device is received as a 10-bit data word at the 26-pin rear connector. Diode isolation on these input lines prevents damage to the GPS 155. The data is then decoded and output to the Main Board data bus via the Interface Board.

The Altitude Decoder Board also provides a discrete input for the GPS SEQ switch. When grounded, this line activates the GPS 155's HOLD mode. This input is sent to the Main Board data bus via the Interface Board.

SECTION 2
TROUBLESHOOTING

2.1 TROUBLESHOOTING EQUIPMENT REQUIRED

- 0-30 Volt DC / 3-Amp Power Supply
- Digital Multimeter
- 20 MHz Oscilloscope

2.2 SELF-TEST FAILURES

The GPS 155 monitors many of its internal functions and displays a message to alert the user should a failure occur. The table below shows the recommended repair for each self-test failure message.

MESSAGE	RECOMMENDED REPAIR*
Altitude input fail	Verify connections to altitude serializer/encoder Replace Altitude Decoder Board (see Section 3.2.2) Replace Interface Board (see Section 3.2.3) Replace Main Board (see Section 3.2.4)
Battery rqrs service	Verify connection of external battery pack to Main Board Replace external battery pack(see Section 3.2.6)
Course input fail	Check ARINC 429 / RS-422 course input connections Replace Main Board (see Section 3.2.4)
Data card failed	Replace NavData® card Replace Interface Board (see Section 3.2.3)
Data card write fail	Replace user data card Replace Interface Board (see Section 3.2.3)
Fuel/Air input fail	Check connections to fuel/air data system Replace Main Board (see Section 3.2.4)
Memory battery low	Replace memory battery (see Section 4.1)
No altitude input	Verify connections to altitude serializer/encoder Replace Altitude Decoder Board (see Section 3.2.2) Replace Main Board (see Section 3.2.4)
Osc needs adjustment	Replace RF/IF Assembly (see Section 3.2.5) Replace Main Board (see Section 3.2.4)
RAM failed	Replace Main Board (see Section 3.2.4)
Receiver failed	Replace Main Board (see Section 3.2.4) Replace RF/IF Assembly (see Section 3.2.5)
ROM failed	Replace ROM (see Section 4.2) Replace Main Board (see Section 3.2.4)
Stored data lost	Replace memory battery (see Section 4.1)

* Where multiple repair actions are listed, they are listed with the most likely failure cause presented first.

2.3 INITIAL TROUBLESHOOTING OPERATIONS

The first step in troubleshooting the GPS 155 is to remove the top and bottom covers (see Section 3.1). Verify that the unit is being properly powered and the internal clock is functional.

NOTE: The NavData® card should be removed before disassembling the unit.

2.3.1 Power Supply Check

1. Check the DC voltage between D805 and ground as shown in Figure 5. The voltage should be between -9.60 and -14.40 volts. If the voltage is out of the limits specified, replace the Main Board.

2. Check the DC voltage between L800 and ground as shown in Figure 5. The voltage should be between 4.8 and 5.2 volts. If the voltage is out of the limits specified, replace the Main Board.

3. Check the DC voltage between D804 and ground as shown in Figure 5. The voltage should be between 48.00 and 72.00 volts. If the voltage is out of the limits specified, replace the Main Board.

4. Check the DC voltage between I806 pin 1 and ground as shown in Figure 6. The voltage should be between 11.75 and 12.25 volts. If the voltage is out of the limits specified, replace the Main Board.

2.3.2 Internal Clock Check

Check the clock speed by placing an oscilloscope probe at I112 pin 25 as shown in Figure 6. The frequency should be approximately 16.4 MHz. If the clock is not operational, replace the RF/IF Board. If the clock still fails to function, replace the Main Board.

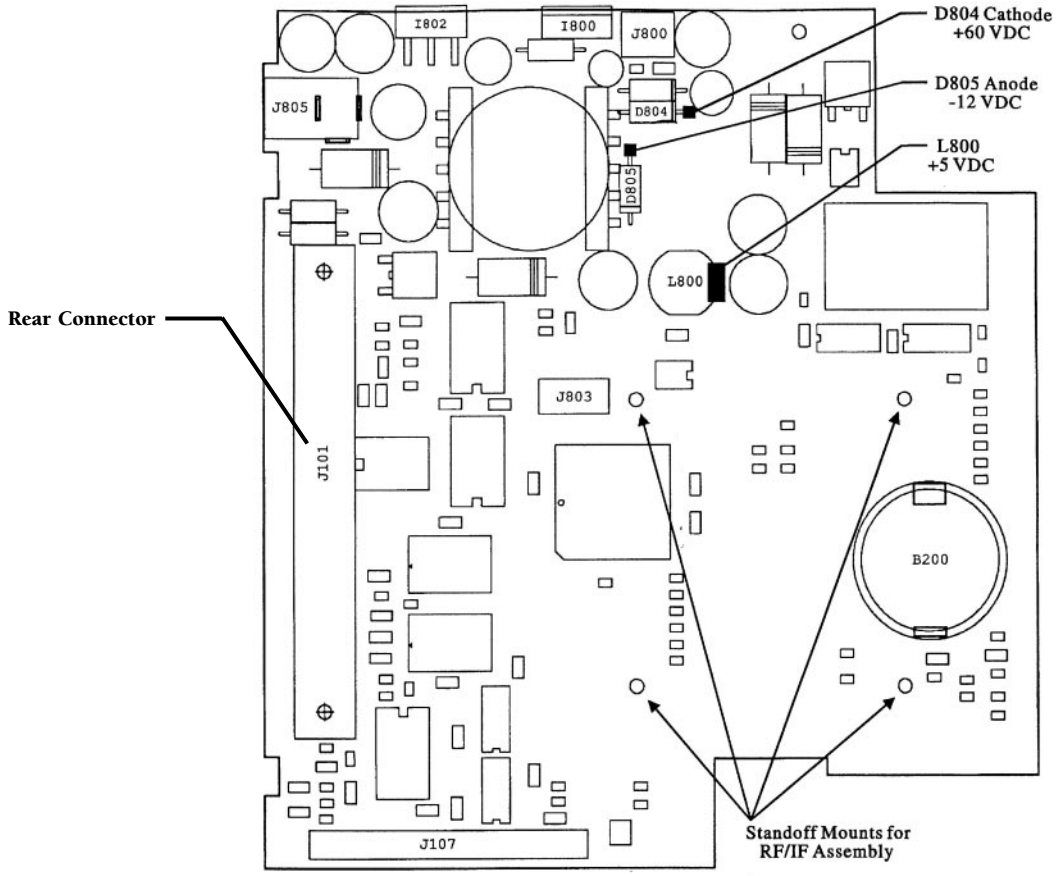


Figure 5
Main Board Testpoints (Top View)

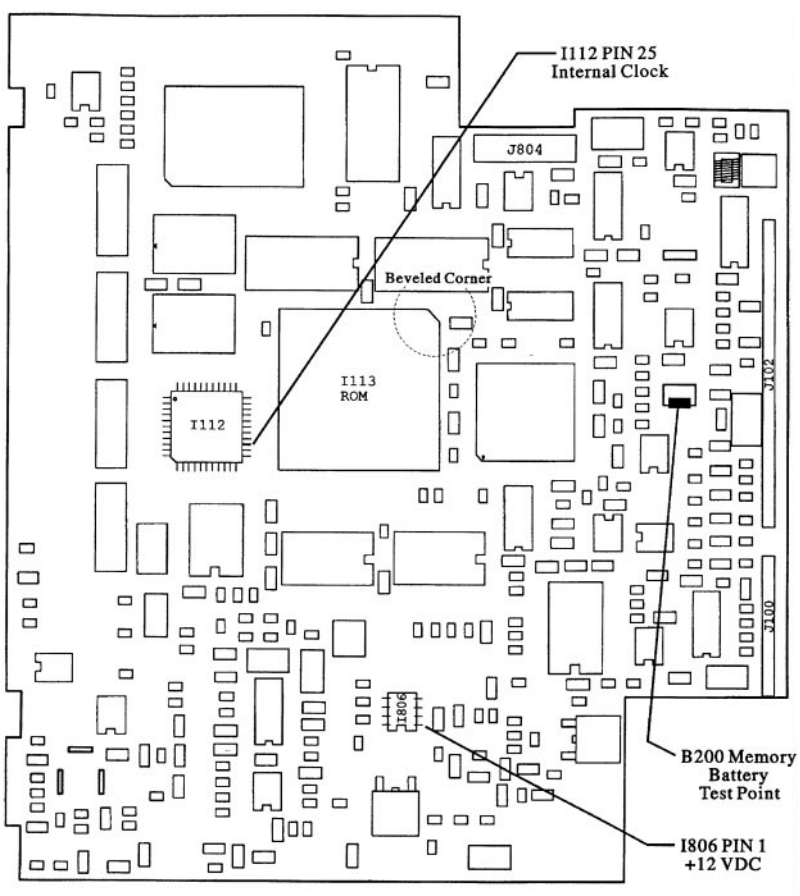


Figure 6
Main Board Testpoints (Bottom View)

2.4 TROUBLESHOOTING CHART

PROBLEM	RECOMMENDED ACTION
Unit will not power on	Check External Power Connection Check External Battery Pack(see Section 3.2 & 4.3.2) Replace Pwr/Dimmer Switch (see Section 3.2.7) Replace Main Board (see Section 3.2.4)
Unit will not power off	Replace Main Board (see Section 3.2.4) Replace Control/Display Unit(see Section 3.2.1) Replace Pwr/Dimmer Switch (see Section 3.2.7)
Display has horizontal or vertical lines	Replace Display Board (see Section 3.2.9) Replace Main Board (see Section 3.2.4) Replace Control/Display Unit(see Section 3.2.1)
Display has missing or dark pixels	Replace Display Board (see Section 3.2.9) Replace Control/Display Unit(see Section 3.2.1)

TROUBLESHOOTING CHART (cont.)

Display brightness not adjustable	Replace Pwr/Dimmer Switch (see Section 3.2.7) Replace Main Board (see Section 3.2.4)
Annunciators & Keycaps have no backlighting	Replace Control/Display Unit (see Section 3.2.1) Replace Main Board (see Section 3.2.4)
Keycap backlighting not uniform	Replace Control/Display Unit (see Section 3.2.1)
Annunciators do not function	Replace Control/ Display Unit (see Section 3.2.1) Replace Main Board (see Section 3.2.4)
No external annunciator output(s) (message, arrival, approach)	Check connections and verify operation in Test Mode (see Section 4.3.2) Replace Main Board (see Section 3.2.4)
Keycaps do not function properly	Replace Control/Display Unit (see Section 3.2.1) Replace Main Board (see Section 3.2.4)
Dual concentric (rotary) knobs do not function properly	Check wiring harness connection from rotary switch to back of Control/Display Unit Replace Rotary Switch Assembly (see Section 3.2.8) Replace Control/Display Unit (see Section 3.2.1)
Approach select switch not functioning properly	Check connections and verify operation in Test Mode (see Section 4.3.2) Replace external switch Replace Main Board (see Section 3.2.4)
OBS select switch ("course select" or "hold") not functioning properly	Check connections and verify operation in Test Mode (see Section 4.3.2) Replace external switch Replace Altitude Decoder Board (see Section 3.2.2) Replace Main Board (see Section 3.2.4)
GPS reception weak or GPS Status Page shows low signal levels	Replace Antenna and/or antenna cable Replace RF/IF Assembly (see Section 3.2.5)
No GPS reception	Check Date/Time Page for correct UTC time[1] Check Position Page for close approximate starting position (within 300 nautical miles)[2] Replace Antenna and/or antenna cable Replace RF/IF Assembly (see Section 3.2.5) Replace Main Board (see Section 3.2.4)
Unit displays velocity when not moving[3]	Replace RF/IF Assembly (see Section 3.2.5)
NiCad battery life is short or NiCad battery inop	Replace External Battery Pack Replace Main Board (see Section 3.2.4)
Unit loses memory in spite of new memory battery	Replace Main Board (see Section 3.2.4)
Unit does not detect low battery	Replace Main Board (see Section 3.2.4)

TROUBLESHOOTING CHART (cont.)

Unit does not detect external power[4]	Check external power connection Replace Main Board (see Section 3.2.4)
No serial data output	Replace Main Board (see Section 3.2.4)
No external CDI output or external CDI functions improperly	Check connections and verify operation in Test Mode (see Section 4.3.2) Replace Main Board (see Section 3.2.4)
Invalid characters displayed	Replace ROM (see Section 4.2) Replace Main Board (see Section 3.2.4)

[1]If UTC Time is incorrect, unit may be reset by holding the CLR key down while turning the unit on. The unit must then be attached to an antenna, allowed to search the sky and collect new almanac data. This process may take 20-30 minutes. CAUTION: All user waypoints/settings will be lost if the unit is reset.

[2]The GPS 155 will eventually perform an AutoLocate™ and lock onto satellites, however this can add an additional 10-15 minutes to the normal lock-on time.

[3]Display of low velocity numbers when not moving can occur when the unit is in 2D mode and should not be considered a problem. However, this should seldom occur in 3D mode.

[4]The "Turning Off" message appears at/below approximately 9 VDC external power.

SECTION 3
DISASSEMBLY INSTRUCTIONS

To avoid damaging the GPS 155's circuit boards and assemblies, the following procedures should be carefully followed. Assembly drawings are included in Section 5 for reference (Figures 12 through 15).

NOTE: The NavData card should be removed before disassembling the unit.

3.1 REMOVAL OF THE COVERS

1. Remove the two M3 x 5mm screws (211-50227-05) retaining the top cover (115-00037-00).
2. Remove the top cover by sliding it rearward approximately 1/4" until the retaining lip is fully exposed. The cover can then be lifted off the unit.
3. Carefully turn the unit over. CAUTION: The GPS 155 contains numerous static-sensitive components. Always observe proper anti-static precautions.
4. Remove the two M3 x 5mm screws (211-50227-05) retaining the bottom cover (115-00038-00).
5. Remove the bottom cover by sliding it rearward about 1/4" until the retaining lip is fully exposed. The cover can then be lifted off the unit.

NOTE: If further disassembly is required, it is a good idea (at this time) to disengage the battery pack wire from the main board (see figure 12).

3.2 BOARD AND MODULE DISASSEMBLY

3.2.1 Control/Display Unit (011-00127-00) Removal

1. Remove the covers as described above.

2. Disconnect the battery pack wiring harness from the 3-pin locking connector (J800) on the main board (see figures 5 and 12).

3. Remove the power/dimmer control knob and shaft (430-00010-00) by loosening the M3 x 3mm set screw (211-00025-00) on the coupling sleeve (125-00021-00). (NOTE: On some early versions of the GPS 155, the shaft extension is connected directly to the power/dimmer switch without an in-line coupler. The control knob is glued to this one piece extension and cannot be removed. If you are replacing the CDU on one of these units, you will need to order a replacement control knob and coupling sleeve as well.)

4. Remove the four M3 x 5mm flat head screws (211-00024-00) which attach the CDU to the chassis and the battery pack.

5. Carefully remove the CDU from the chassis, pulling the assembly away from the two Main Board connectors (J100 and J102) and the power/dimmer switch.

3.2.2 Altitude Decoder Board (012-00090-00) Removal

1. Remove the covers as described in Section 3.1.

2. Disconnect the battery pack wiring harness from the 3-pin connector (J800) on the Main Board (see Figures 5 and 12).

3. Remove the two #4-40 standoffs (211-63234-08) which hold the 26-pin DSUB connector to the chassis.

4. Carefully pull the Altitude Decoder Board toward the front of the unit approximately 1/4" until the 26-pin DSUB connector is clear of its cutout on the chassis. Lift the Altitude Decoder Board away from the Main Board and chassis.

5. Remove the ribbon cable connector (J701) from the Altitude Decoder Board.

3.2.3 Interface Board (012-00031-01) Removal

1. Remove the covers as described in Section 3.1.

2. Remove the Control/Display Unit as described in Section 3.2.1.

3. Remove the Altitude Decoder Board as described in Section 3.2.2.

4. Remove the four M1.7 x 5mm flat head screws (211-56201-05) retaining the data card race (145-00056-00) and Interface Board.

5. Slip the data card race off the Interface Board connector (J700).

6. Carefully pull the Interface Board upward out of the unit, disengaging it from the Main Board Connector (J107).

3.2.4 Main Board Sub-Assembly Removal

The Main Board Sub-Assembly consists of the Main Board (012-00089-00) and the RF/IF Assembly (012-00091-00). If required, this sub-assembly may be further dismantled by following the steps in Section 3.2.5.

1. Remove the covers as described in Section 3.1.
2. Remove the Control/Display Unit as described in Section 3.2.1.
3. Remove the Altitude Decoder Board as described in Section 3.2.2.
4. Remove the hex nut securing the BNC connector to the chassis. This nut is 9/16" and may be removed with a deep 12-point socket.
5. Pull the BNC connector out of its cutout on the chassis.
6. Remove the heat sink clamping bar (115-00049-00, see Figure 12 - Detail A) by removing the M3 x 5mm mounting screw (211-50227-05).
7. Remove the heat sink insulator (250-00016-00) from regulator I800 (see Figure 12 - Detail A) and save this piece for later reassembly.
8. Carefully turn the unit over.
9. The power/dimmer switch uses a flexible circuit cable for connection to the Main Board. This flexible circuit cable is inserted into a ZIF connector (J804). Pull up on the retaining lip of the ZIF connector. Gently pull the flexible circuit cable out of the ZIF connector. Take care not to crease the flexible circuit cable.
10. Remove the two #4-40 standoffs (211-63204-08) which hold the 37-pin DSUB connector to the chassis.
11. Remove the M3 x 5mm screw (211-50227-05) and the M3 x 10mm screw (211-50227-15) holding the Main Board to the chassis.
12. Carefully slide the Main Board upward; pulling it away from the power/dimmer switch and the Interface Board Connector (J702).

3.2.5 RF/IF Assembly (012-00091-00) Removal

1. Remove the covers as described in Section 3.1.
2. Remove the Altitude Decoder Board as described in Section 3.2.2.
3. Remove the hex nut securing the BNC connector to the chassis. This nut is 9/16" and may be removed with a deep 12-point socket.
4. Pull the BNC connector out of its cutout on the chassis.
5. Remove the four screws (211-50202-15) and spacers (233-00012-00) which secure the RF/IF Assembly to the Main Board.
6. Carefully pull the RF/IF Assembly upward, disengaging it from the Main Board Connector (J803). (NOTE: With the mounting screws removed, the cover for the RF/IF Assembly will be loose. Grip the RF/IF Assembly firmly by the sides, instead of by its cover, when lifting upward.)

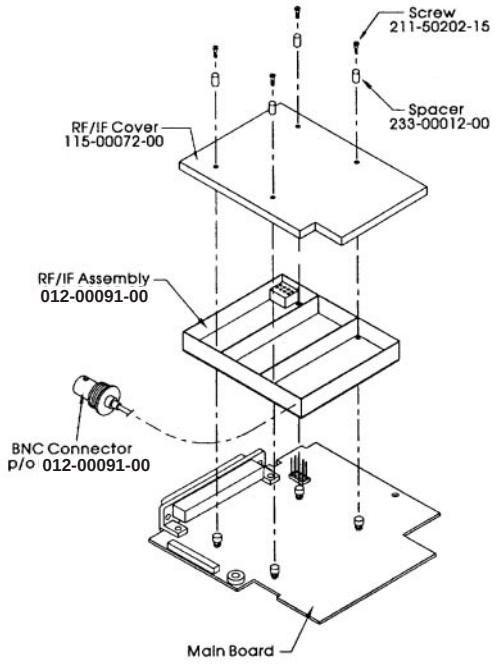


Figure 7
RF/IF Assembly Removal

3.2.6 Battery Pack (011-00067-00) Removal

1. Remove the covers as described in Section 3.1.

2. Remove the heat sink clamping bar (115-00049-00, see Figure 12-Detail A) by removing the M3 x 5mm mounting screw (211-50227-05). (Note: Removal of the Altitude Decoder, Interface and Main Boards is not required to remove the battery pack from the unit.)

3. Remove the heat sink insulator (250-00016-00) from the regulator I800 (see figure 12-Detail A) and save this piece for later reassembly.

4. Remove the two M3 x 5mm flat head screws (211-00024-00) which attach the CDU to the battery pack.

5. Remove the three M3 x 5mm screws (211-50227-05) securing the battery pack to the chassis. (Note: One screw is recessed in a hole on the side of the battery pack.)

6. Slide the battery pack cable and connector (P800) through the cutout in the chassis.

3.2.7 Power/Dimmer Switch (011-CS032-00) Removal

1. Remove the covers as described in Section 3.1.

2. Remove the Control/Display Unit as described in Section 3.2.1.

3. Remove the Main Board Sub-Assembly as described in Section 3.2.4.

4. Remove the coupling sleeve (125-00021-00) by unscrewing the pivot pin screw (211-00030-00).

5. Remove the hex nut securing the power/dimmer switch to the chassis. This nut is 7/16" and may be removed with a deep, thin-walled 12-point socket.

6. Slide the power/dimmer switch out of the mounting hole on the chassis.

3.2.8 Rotary Switch Assembly (011-CS033-00) Removal

1. Remove the covers as described in Section 3.1

2. Remove the Control/Display Unit as described in Section 3.2.1

3. Remove the two rotary switch knobs by loosening the two M3 x 4mm set screws on the inner knob (430-00002-00). After removing the inner knob, gently pull the outer knob off of the rotary switch shaft.

4. Disconnect the rotary switch wiring harness from the connector on the Display Board.

5. Remove the hex nut securing the rotary switch to the Control/Display Unit. This nut is 1/2" and may be removed with a deep 12-point socket.

3.2.9 Display Board (012-00029-00) Removal

1. Remove the covers as described in Section 3.1.

2. Remove the Control/Display Unit as described in Section 3.2.1.

3. Disconnect the rotary switch wiring harness from the connector on the Display Board.

4. Remove the four M2.3 x 6mm screws (211-00028-00) that secure the Display Board to the CDU bezel.

5. Carefully pull the Display Board away from the CDU bezel, disengaging it from the Keypad Board connector. (NOTE: Retain the four rubber grommets [252-00005-00] for later reassembly.)

3.3 REASSEMBLING THE UNIT

1. Attach the power/dimmer switch to the chassis by reversing the steps followed in Section 3.2.7. The switch is correctly installed when the contacts and flexible circuit cable are pointed away from the chassis frame.

2. Ensure that the power/dimmer switch is in the "off" position

3. Slide the battery pack connector (P800) and cable into the cutout in the chassis.

4. Mount the battery pack to the chassis using three M3 x 5mm screws (211-50227-05).

5. Attach the RF/IF Assembly to the Main Board by reversing the steps followed in Section 3.2.5.

6. Mount the Main Board Sub-Assembly on the chassis by reversing the steps followed in Section 3.2.4. Be sure to pull up on the retaining lip of the ZIF connector (J804) before inserting the flexible circuit cable. Also, ensure that the heat sink insulator (250-00016-00) is installed on regulator I800 before installing the heat sink clamping bar (see Figure 12 - Detail A).

7. Mount the Interface Board to the chassis by reversing the steps followed in Section 3.2.3.

8. Install the Altitude Decoder Board by reversing the steps followed in Section 3.2.2. Carefully observe proper orientation and alignment when reconnecting the ribbon cable to the board. Do not connect the battery pack wiring harness to the Main Board until the Control/Display Unit is installed.

9. Mount the Display Board to the CDU bezel by reversing the steps followed in Section 3.2.9. Be sure to reinstall the four rubber grommets before mounting the board.

10. Mount the Rotary Switch Assembly to the Control/Display Unit by reversing the steps followed in Section 3.2.8. The switch is correctly installed when the wiring harness points toward the top of the unit. Torque hex nut to 25±3 in oz.

11. Install the Control/Display Unit by reversing the steps followed in Section 3.2.1. Gently slide the CDU onto the two Main Board connectors (J100 and J102), observing proper pin alignment during the process.

12. Connect the battery pack wiring harness to the 3-pin locking connector (J800) on the Main Board (see figure12).

13. Install the top and bottom covers by reversing the steps followed in Section 3.1.

SECTION 4
SERVICE AND TESTING

4.1 MEMORY BATTERY REPLACEMENT

The GPS 155 utilizes a built-in lithium battery to maintain user waypoints/settings stored in RAM. This battery has an operational life of up to five years. Should the battery require replacement, as indicated by the "Memory battery low" message, disassembly of the unit will be required to access the battery clip.

When replacing the memory battery, all user waypoints/settings may be lost. If this occurs the message "Stored Data Lost" will be displayed. The unit must then be attached to an antenna, allowed to search the sky and collect new almanac data before it will be usable again. This process may take 20-30 minutes.

1. Remove the covers as described in Section 3.1.

2. Remove the Control/Display Unit as described in Section 3.2.1.

3. Remove the four screws (211-50202-15) and spacers (233-00012-00) which secure the RF/IF Assembly to the Main Board.

4. Carefully pull the RF/IF Assembly upward, disengaging it from the Main Board Connector (J803) Place the RF/IF Assembly to the side of the unit. (NOTE: With the mounting screws removed, the cover for the RF/IF Assembly will be loose. Grip the RF/IF Assembly firmly by the sides, instead of by its cover, when lifting upward.)

5. Remove the old battery by gently pushing it toward the back of the unit and out of the battery clip. A tuning tool, or similar flat-tipped instrument, may be used to aid removal of the battery, but EXTREME CAUTION should be exercised to prevent damage to the Main Board.

6. Immediately install a new battery (positive side up) into the battery clip.

7. Secure the RF/IF Assembly to the Main Board using the four screws (211-50202-15) and spacers (233-00012-00).

8. Install the Control/Display Unit by reversing the steps followed in Section 3.2.1. Gently slide the CDU onto the two Main Board connectors (P501 and P502), observing proper pin alignment during the process.

9. Turn the GPS 155 on.

10. Press ENT to accept "NORMAL" mode operation.

11. Press ENT again to accept the Database Page.

12. Verify that the "Memory battery low" message does not appear on the Message Page by pressing the MSG key.

13. Turn the GPS 155 off and carefully turn the unit over.

14. Verify that the memory battery voltage (from test point to ground, see Figure 6) is at least 2.9 VDC.

15. Install the top and bottom covers by reversing the steps followed in Section 3.1.

4.2 ROM REPLACEMENT

If a software update is required, it may be performed by replacing the operating system ROM located on the Main Board. When replacing the ROM, all user waypoints/settings will be lost. The message "Stored Data Lost" will be displayed. The unit must then be attached to an antenna, allowed to search the sky and collect new almanac data before it will be usable again. This process may take 20-30 minutes. (A user data card is available to save user waypoints/settings prior to replacing the ROM. Refer to page 5 of this manual for more information.)

1. Turn the GPS 155 is turned off.

2. Remove the bottom cover as described in Section 3.1.

3. Locate the ROM in the middle of the Main Board, as shown in figure 6.

NOTE: The ROM removal tool (P/N T00-00007-00) is contoured for insertion into either of the two extraction cavities on the chip carrier socket. Remove the chip by inserting the extraction tool with the correct angle (see figure 8) and pivoting the tool on its heel against the socket.

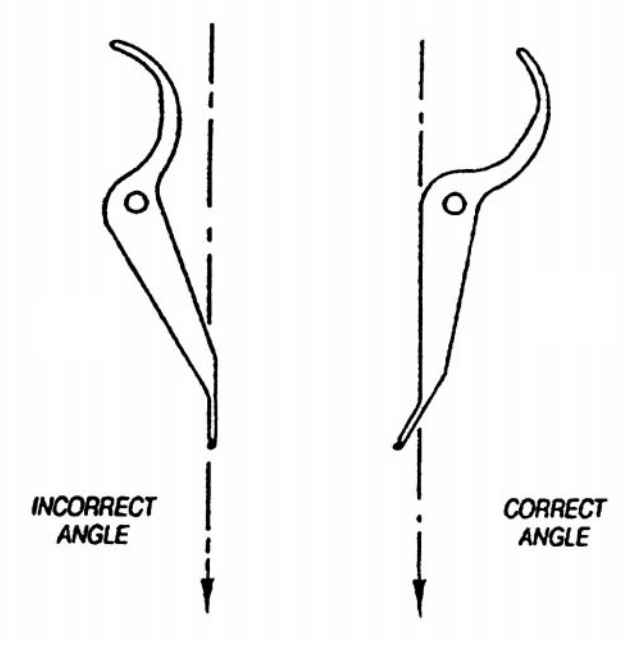


Figure 8
ROM Tool Insertion

4. ROM Extraction Procedure:

    a. Orient the socket and tool as shown in figure 9.

CAUTION: Do not attempt to completely extract chip from chip carrier socket on the first extraction. Lift from one side until the corner is above the socket, then repeat the procedure on the opposite corner.

    b. Insert the extraction tool into the socket so that the front angle of the tool is perpendicular to the chip carrier. NOTE: Insertion of the tool with an incorrect angle will result in damage to the chip carrier socket. The incorrect angle will bottom under the standoff rather than the bottom of the chip.

    c. Lower the extraction tool into the extraction cavity until it bottoms.

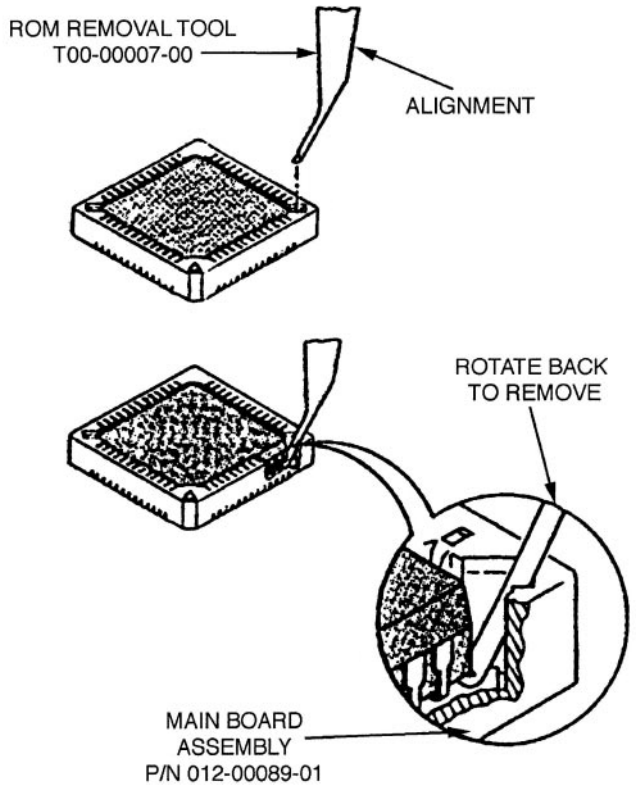


Figure 9
ROM Removal

d. Using a slight downward pressure, rotate the tool away from the chip carrier until the corner of the chip lifts away from the chip carrier socket.

e. Repeat on opposite extraction slot and lift chip out of chip carrier socket.

5. Inspect the ROM socket to ensure that the contacts and case are in good condition.

6. Insert the new ROM into the socket so that the beveled corner of the ROM chip aligns with the beveled corner of the socket (see Figure 6). Make certain that the ROM is well seated!

7. Hold the CLR key down while rotating the power/dimmer knob clockwise from the 'off' position. Verify that the Self Test Page is displayed (shows the software version number and copyright notice). Also, press the MSG key to verify that the "Stored data lost" message appears on the Message Page and the "ROM failed" message does not appear. (Failure to clear memory after ROM replacement can cause unpredictable operating problems.)

8. Turn the GPS 155 off.

9. Install the bottom cover by reversing the steps followed in Section 3.1.

10. Connect an outside antenna to the GPS 155, turn the unit on and allow it to recollect almanac data as described above. This process is complete when the "Collecting data" message is no longer displayed on the Message Page.

4.3 FINAL TEST

After completing all necessary maintenance or service, the following test procedure is provided to ensure that all GPS 155 functions are operating properly.

4.3.1 Test Equipment Required

- 0-30 Volt DC / 3 Amp Power Supply
- GPS 150/(155/155)/GNC Manual Test Panel (T10-00003-02)
- Red and Black Cables with Banana Plugs (3' length recommended)
- Digital Multimeter

4.3.2 Setup

1. Preset the power supply to +28 VDC.
2. Connect the positive output of the power supply to the red DC IN + jack at the back of the test panel. Connect the negative output of the power supply to the black DC IN - jack at the back of the test panel.
3. Connect the J2 and J101 wiring harness assemblies to the front of the test panel.
4. Connect the positive and negative digital multimeter leads to the HI and LO FUNCTION SELECT outputs on the front of the test panel. Set the DMM to measure DC voltage.
5. Set the CAL/NORMAL switch to NORMAL and set the GPS 150/(155/155)/GNC switch to GPS155/155.
6. Plug one end of the AC power cord into the back of the test panel and the other end into a 120VAC outlet.
7. Turn the FUNCTION SELECT switch to POWER IN. Ensure that the PANEL POWER and UNIT POWER push-button switches are OFF (not lighted).
8. Turn on the power supply, push the PANEL POWER switch and verify that it lights up. Push the UNIT POWER switch and verify that it lights up.
9. Monitor the POWER IN voltage with the DMM and set the power supply for +28.0 VDC.
10. Push the UNIT POWER switch to turn unit power OFF.
11. Connect the J2 and J101 wiring harness assemblies to the back of the GPS 155.
12. Push the UNIT POWER switch to turn unit power ON.

4.3.3 Final Test Procedure

1. Test Mode Activation / Display Test:

   a. Hold the ENT key down while rotating the power/dimmer knob clockwise from the 'off' position.

   b. Verify that the GPS 155 enters test mode. There are three test patterns displayed when first activating test mode. The first test pattern illuminates all thirty-five pixels in the first character column of each row and cycles through the remaining nineteen character columns. The second test pattern illuminates the first column of pixels in each of the 20 character columns and cycles through the remaining four pixel columns. The third test pattern illuminates the first row of pixels in each of the three character rows and cycles through the remaining six pixel rows.

c. Observe the test patterns and verify that the display is working properly.

d. Rotate the power/dimmer knob counterclockwise, but not past the detent (off) position, to ensure that the display is dimmable.

2. CDI Deflection Test:

a. Rotate the outer function knob clockwise. The CDI Test Page will be displayed:

b. Turn the FUNCTION SELECT switch on the test panel to position #3.

c. Press the CRSR key.

d. If necessary, rotate the inner function knob to select CENTERED. Verify that the DMM voltage is 0 ±15 millivolts.

e. Rotate the inner function knob clockwise to select FULL RIGHT. Verify that the DMM voltage is -150 ±15 millivolts.

f. Rotate the inner function knob clockwise to select MAX RIGHT. Verify that the DMM voltage is -300 ±30 millivolts.

g. Rotate the inner function knob clockwise to select MAX LEFT. Verify that the DMM voltage is +300 ±30 millivolts.

h. Rotate the inner function knob clockwise to select FULL LEFT. Verify that the DMM voltage +150 ±15 millivolts.

3. CDI To/From Flag Test:

a. Rotate the outer function knob clockwise.

b. Turn the FUNCTION SELECT switch on the test panel to position #2.

c. If necessary, rotate the inner function knob to select FLAG. Verify that the DMM voltage is 0 ±15 millivolts. Units with Mod Status 1: DMM voltage is 0 ±10 millivolts.

d. Rotate the inner function knob clockwise to select FROM. Verify that the DMM voltage is -83 ±20 millivolts. Units with Mod Status 1: DMM voltage is -190 ±40 millivolts.

e. Rotate the inner function knob clockwise to select TO. Verify that the DMM voltage is 83 ±20 millivolts. Units with Mod Status 1: DMM voltage is +190 ±40 millivolts.

4. CDI Nav Flag Test:

a. Rotate the outer function knob clockwise.

b. Turn the FUNCTION SELECT switch on the test panel to position #1.

c. If necessary, rotate the inner function knob to select IN VIEW. Verify that the DMM voltage is 0 ±10 millivolts.

d. Rotate the inner function knob clockwise to select OUT OF VIEW. Verify that the DMM voltage is 375 ±80 millivolts.

5. Super Flag Output Test:

a. Rotate the outer function knob clockwise.

b. Turn the FUNCTION SELECT switch on the test panel to position #4.

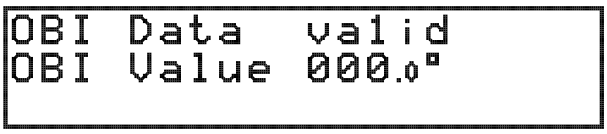
c. If necessary, rotate the inner function knob to select IN VIEW. Verify that the DMM voltage is less than 0.25 VDC.

d. Rotate the inner function knob clockwise to select OUT OF VIEW. Verify that the DMM voltage is greater than 26.5 VDC.

6. OBI Output Test:

a. Press the CRSR key.

b. Rotate the outer function knob clockwise to display the OBI Test Page:



c. Press the CRSR key.

d. Rotate the outer function knob clockwise until VALUE is flashing.

e. Rotate the inner function knob clockwise to select CLOCK.

f. Turn the FUNCTION SELECT switch on the test panel to position #14.

g. Rotate the outer function knob clockwise until LOW flashes. Verify that the DMM voltage is less than 1.0 VDC.

h. Rotate the inner function knob to select HIGH. Verify that the DMM voltage is greater than 4.5 VDC.

i. Rotate the outer function knob counterclockwise until CLOCK flashes.

j. Rotate the inner function knob clockwise to select DATA.

k. Turn the FUNCTION SELECT switch on the test panel to position #15.

l. Rotate the outer function knob clockwise until LOW flashes. Verify that the DMM voltage is less than 1.0 VDC.

m. Rotate the inner function knob to select HIGH. Verify that the DMM voltage is greater than 4.5 VDC.

n. Rotate the outer function knob counterclockwise until DATA flashes.

o. Rotate the inner function knob clockwise to select SYNC.

p. Turn the FUNCTION SELECT switch on the test panel to position #16.

q. Rotate the outer function knob clockwise until LOW flashes. Verify that the DMM voltage is less than 1.0 VDC.

r. Rotate the inner function knob to select HIGH. Verify that the DMM voltage is greater than 4.5 VDC.

7. RS-232 / RS-422 / ARINC 429 Loopback Tests:

a. Press the CRSR key.

b. Rotate the outer function knob until the I/O Test Page is displayed:

c. Verify that the I/O Test Page indicates “CH 1 OK” and “CH 2 OK”.

d. Verify that the I/O Test Page indicates “RS422 OK”.

e. Verify that the I/O Test Page indicates “A429 OK”.

8. Annunciator Output Test:

a. Rotate the outer function knob until the Annunciator Test Page is displayed:

b. Turn the FUNCTION SELECT switch on the test panel to position #5.

c. Press the CRSR key.

d. Rotate the inner function knob to turn the front panel annunciators ON. Verify that all six annunciators on the GPS 155 are lit.

e. Rotate the power/ dimmer knob counterclockwise, but not past the detent (off) position, to ensure that the annunciators are dimmable.

f. Rotate the inner function knob to turn the front panel annunciators OFF. Verify that all six annunciators on the GPS155 are off.

g. Rotate the outer knob counterclockwise to select the APPR annunciator test.

h. With the APPR annunciator OFF, verify that the DMM voltage is greater than 4.5 VDC.

i. Rotate the inner function knob to turn the APPR annunciator ON. Verify that the DMM voltage is less than 0.3 VDC.

j. Turn the FUNCTION SELECT switch on the test panel to position #6.

k. Rotate the outer function knob until the MSG annunciator test is selected.

l. With the MSG annunciator OFF, verify that the DMM voltage is greater than 4.5 VDC.

m. Rotate the inner function knob to turn the MSG annunciator ON. Verify that the DMM voltage is less than 0.3 VDC.

n. Turn the FUNCTION SELECT switch on the test panel to position #7.

o. Rotate the outer function knob clockwise to select the ARRVL annunciator test.

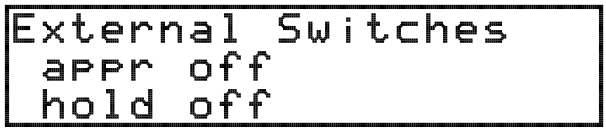
p. With the ARRVL annunciator OFF, verify that the DMM voltage is greater than 4.5 VDC.

q. Rotate the inner function knob to turn the ARRVL annunciator ON. Verify that the DMM voltage is less than 0.3 VDC.

9. External Switches Test:

a. Press the CRSR key.

b. Rotate the outer function knob until the External Switches Test Page is displayed:



c. Toggle APPR SELECT switch on test panel to up position. Verify that the External Switches Test Page indicates "APPR ON"

d. Toggle APPR SELECT switch on test panel to down position. Verify that the External Switches Test Page indicates "APPR OFF".

e. Toggle OBS HOLD switch on test panel to up position. Verify that the External Switches Test Page indicates "HOLD ON".

f. Toggle OBS HOLD switch on test panel to down position. Verify that the External Switches Test Page indicates "HOLD OFF".

10. Altitude Decoder Test:

This test exercises each altitude data line individually. Most altitude codes presented will be invalid, however, ALTITUDE DECODER LINE SELECT switch positions C1(input line C1 valid) and C2 (input line C2 valid) indicate altitude readings of -800 and -1000 feet, respectively.

a. Rotate the outer function knob until the Altitude Decoder Test Page is displayed:

b. Turn the ALTITUDE DECODER LINE SELECT switch on the test panel to position D4. Verify that D4 on the Altitude Decoder Test Page indicates "1". All other altitude inputs should still indicate "0".

c. Continue to step through ALTITUDE DECODER LINE SELECT switch positions A1, A2, A4, B1, B2, B4, C1, C2, and C4. Verify that only one input line (A1, A2, A4, B1, B2, B4, C1, C2, or C4) indicates "1" for each switch position. All other altitude inputs should still indicate "0".

d. Turn the ALTITUDE DECODER LINE SELECT switch to RMT ENT position. Verify that all altitude inputs indicate "0".

11. OBS Selected Course Test:

a. Rotate the outer function knob until the OBS Selected Course Test Page is displayed:

b. Turn the OBS BEARING switch on the test panel to 150°. Verify that the input course is 150° ±9° and "CALIB?" appears in the lower right corner of the test page.

c. Press the CRSR key.

d. Press the ENT key on the GPS 155 to calibrate the unit. There will be a brief delay while the unit performs the calibration. Verify that the input course is now 150° ± 0.2°.

e. Turn the OBS BEARING switch on the test panel to the 60°, 240°, and 330° positions. Verify that in each instance the input course is within ± 2°.

12. External Power / Battery Tests:

a. Rotate the outer function knob until the Battery Test Page is displayed:

b. Turn the FUNCTION SELECT switch on the test panel to position #11.

c. Using the voltage reading on the DMM, adjust the external power supply to 8.0 VDC. Verify that the Battery Test Page indicates "BATTERY".

d. Adjust the external power supply to 10.5 VDC. Verify that the Battery Test Page indicates "EXT PWR".

e. Using a wall charger (GARMIN Part no. 362-00010-00 or 362-00014-00), plug wall charger into charger plug on rear of GPS 155. Verify that the Battery Test Page indicates "CHARGER".

f. Unplug the wall charger jack from the GPS 155 and adjust the external power supply to 28.0 VDC. Verify that the Battery Test Page indicates "MEMORY BATT OK".

g. Turn the FUNCTION SELECT switch on the test panel to position #13.

h. Monitor the NiCad battery voltage on the DMM.

i. Push the UNIT POWER switch on the test panel to turn off external power to the GPS 155. Verify that the Battery Test Page indicates "INTRNL BATT OK". An "INTRNL BATT LOW" condition occurs if battery voltage is less than 5.3 VDC and indicates that the battery needs charging.

j. Push the UNIT POWER switch on the test panel to turn on external power.

k. Turn the FUNCTION SELECT switch on the test panel to position #11.

l. Using the voltage reading on the DMM, adjust the external power supply to 28.0 VDC.

m. Plug the wall charger jack into the charger socket at the rear of the GPS 155. Verify that the Battery Test Page indicates "TRICKLE CHARGE".
n. Unplug the wall charger jack from the GPS 155. Verify that the Battery Test Page indicates "RAPID CHARGE".

o. Allow sufficient time for the external NiCad battery to charge. If the battery is fully discharged, this may take up to 1.5 hours. After the battery is charged, the Battery Test Page should indicate "MAINT CHARGE". A failure is indicated any time the Battery Test Page indicates "NO CHARGE".

p. Turn the FUNCTION SELECT switch on the test panel to position #13.

q. Monitor the external NiCad battery voltage on the DMM.

r. Push the UNIT POWER switch on the test panel to turn off external power to the GPS 155. Verify that the Battery Test Page indicates "REMOTE BATT OK". (The Battery Test Page indicates "REMOTE BATT TMP OK" when using wall charger power.) A failure is indicated when "OVR TMP" is displayed.

s. Turn the FUNCTION SELECT switch to position #12. Verify that the DMM voltage is less than 0.5 VDC.

13. GPS Receiver Noise Test:

a. Depress the ENT key while powering up the unit. THis puts the unit into Test Mode.

b. Rotate the outer function knob until the Receiver Test Page is displayed:

c. Terminate the GPS receiver's antenna connection into a 50 ohm load.

d. The bottom line of the display represents the receiver noise level. Verify that this number is within the range of 1800-2200.

14. Operational Test:

a. Turn the GPS 155 OFF.

b. Insert a Jeppesen NavData® card.

c. Turn the GPS 155 ON normally, without entering test mode. Verify that the GPS 155 passes its self test. A failure is indicated by one of the messages listed in Section 2.2.

d. Verify that the GPS 155 correctly reads the NavData® card and indicates the type, effective date and expiration date.

e. Press the ENT key and verify that the Satellite Status Page is displayed.

f. Press the MSG key and verify that the Message Page is displayed.

g. Press the Direct To key and verify that the GO TO Page is displayed.

h. Rotate the inner function knob to select a letter or number on the display.

i. Press the CLR key and verify that the selected letter/number disappears.

j. Press the NRST key. Verify that a Nearest Waypoint Page is displayed and the annunciator next to the SET key is on.

k. Press the SET key. Verify that a Set-up Page (Satellite Status Page) is displayed and the annunciator next to the SET key is on.

l. Press the RTE key. Verify that a Route Page is displayed and the annunciator next to the RTE key is on.

m. Press the WPT key. Verify that the Select Waypoint Type Page is displayed and the annunciator next to the WPT key is on.

n. Press the CRSR key and verify that APT? flashes.

o. Rotate the outer function knob clockwise and verify that VOR? flashes.

p. Press the NAV key. Verify that a Navigation Page is displayed.

q. Turn the GPS 155 OFF.

15. Satellite Tracking Test:

The Satellite Tracking Test ensures that the GPS 155 has current almanac information and is able to lock onto a sufficient number of satellites to provide a position. This test also verifies that the signal strength of the satellites received is at an acceptable level.

a. Turn the GPS 155 off.

b. Connect the unit to a GA 56 antenna mounted outside with a clear view of the sky, through a coax with a 10 dB ± 1 dB cable loss @ 1.5 GHz. NOTE: Attenuation pads must not be used since the unit supplies the GA 56 with DC power. A 10 dB cable is available through GARMIN (P/N 320-00088-00).

c. Turn on the GPS 155. Go to the Satellite Status Page (see Pilot's Guide for instructions).

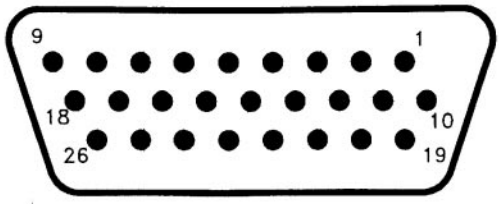
d. Allow the unit to lock onto the satellites. If the unit has current almanac data, it will list the visible satellites on the row labeled 'SAT' and will begin acquiring satellites in a period of a few minutes. If the unit indicates 'SEARCH SKY', instead of 'ACQUIRING', it must search the sky for available satellites and collect almanac data. A "search the sky" operation may take 20-30 minutes to complete.

e. The unit must enter 3D navigation mode, upon completion of "acquiring" or "search the sky" operations.

f. The unit must display the following:

    1) 4 satellites with signal strength of '3' or greater.

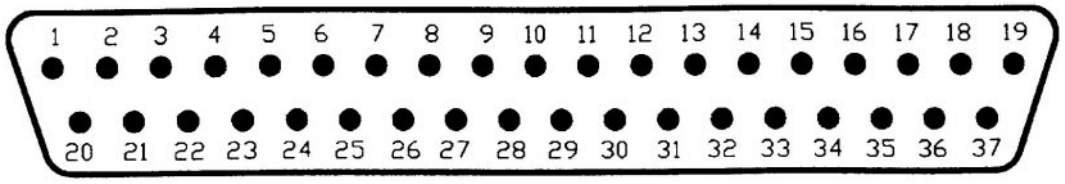
    2) The average signal strength on satellites above 20° elevation shall be greater than or equal to 3.5 (see Pilot's Guide for instructions). Satellites that are acquiring should not be included in the average signal strength calculation.



VIEW OF J2 CONNECTOR FROM BACK OF UNIT

PIN #	DESCRIPTION
13	GPS SEQUENCE HOLD LOW
14	ALTITUDE D4
15	ALTITUDE A1
16	ALTITUDE A2
17	ALTITUDE A4
18	ALTITUDE B1
19	ALTITUDE B2
20	ALTITUDE B4
21	ALTITUDE C1
22	ALTITUDE C2
23	ALTITUDE C4
24	ALTITUDE COMMON

Figure 10
J2 Rear Connector Pinout Definition



VIEW OF J101 CONNECTOR FROM BACK OF UNIT

PIN #	DESCRIPTION
1	GPS D-BAR LEFT +
2	GPS TO +
3	GPS FLAG +
4	GPS FLAG -
5	GPS D-BAR RIGHT +
6	GPS FROM +
7	GPS OBI CLOCK
8	GPS OBI DATA
9	GPS APPROACH ARM LOW
10	GPS SUPER FLAG HIGH
11	RS-422 IN HI
12	GPS ARRIVAL ALARM LOW
13	GPS APPROACH ACTV LOW
14	GPS ROTOR C
15	ARINC 429 OUT B
16	ARINC 429 OUT A
17	RS-232 IN 1
18	RS-232 IN 2
19	RS-232 OUT 2
20	GPS MESSAGE ACTV LOW
23	GPS OBI SYNC
24	RS-232 OUT 1
25	AIRCRAFT POWER (10-33 VDC)
26	GROUND
27	RS-422 IN LO
32	ARINC 429 IN A
33	ARINC 429 IN B
35	GPS STATOR D
37	GPS STATOR F

Figure 11
J101 Rear Connector Pinout Definition

SECTION 5
ILLUSTRATED PARTS LIST

5.1 LIST OF REPLACEABLE PARTS

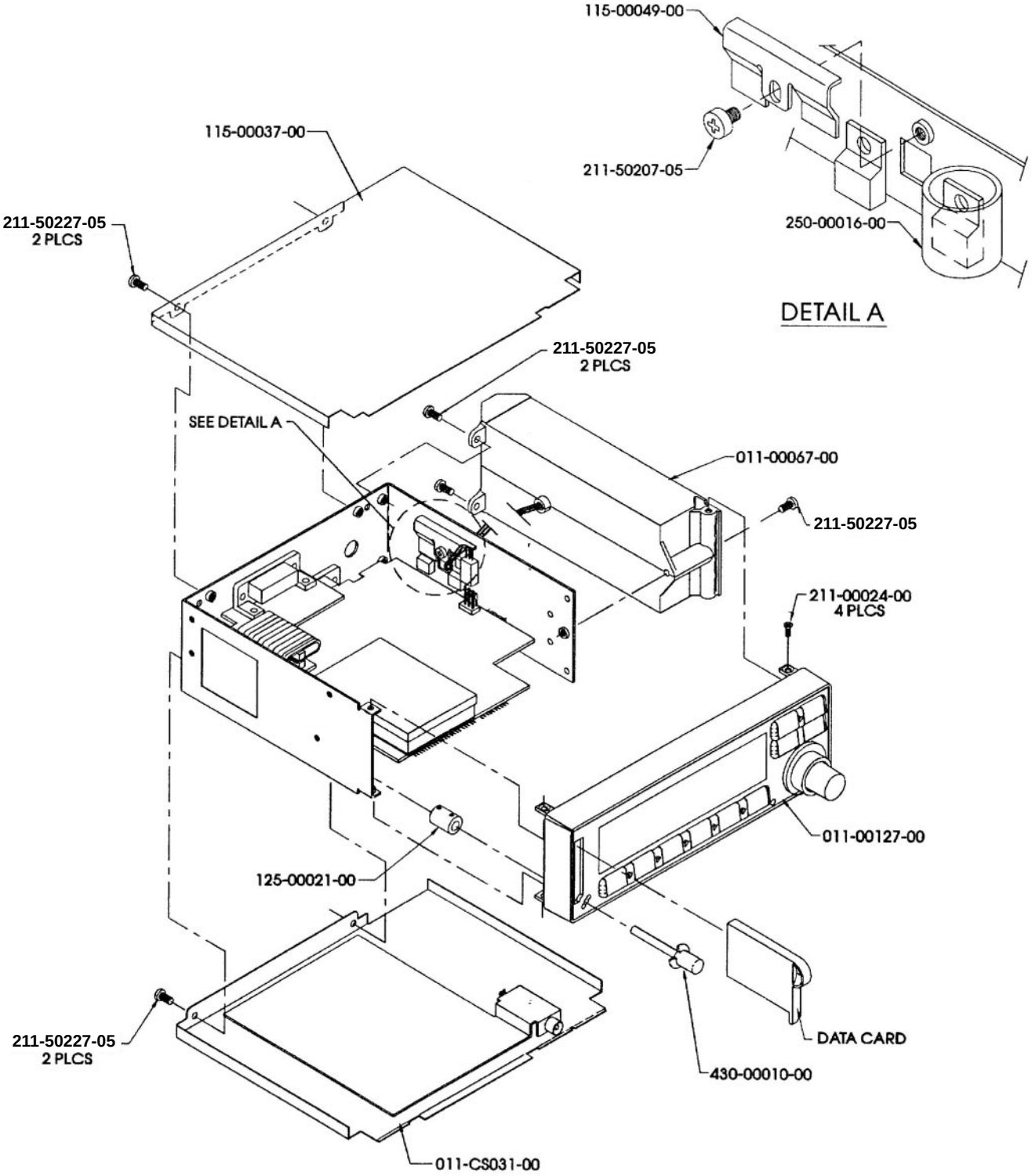
The table below lists the parts which are available to authorized maintenance shops.

User Data Card	010-10032-03
Rechargeable NiCad Battery Pack	011-00067-00
Control Display Unit	011-00127-00
TSO'd RF/IF Assembly w/BNC Connector	012-00091-00
Bottom Cover, with Pawl Latch	011-CS031-00
Power/Dimmer Switch w/Flex Ckt. Cable	011-CS032-00
Rotary Switch Assy. w/Wiring Harness	011-CS033-00
Display Board Assy.	012-00029-00
Main Board Assy.	012-00089-00
Interface Assy.	012-00031-01
Altitude Decoder Board	012-00090-00
RG 58 10 dB Cable @ 1.5 GHz	320-00088-00
Lithium Cell, 2032	360-00003-01
Wall Charger / AC Adapter	362-00010-00
Wall Charger / AC Adapter	362-00014-00
Knob, Inner, (w/ set screws)	430-00002-00
Knob, Outer	430-00004-00
Knob, Power Dimmer, with shaft	430-00010-00
Programmed EPROM	541-B0034-00
ROM Removal Tool	T00-00007-00

5.2 ASSEMBLY DRAWINGS

The following assembly drawings are provided for part identification and to aid in assembly/disassembly of the GPS 155.

Figure 12



GPS 155 Assembly Drawing (View 1)

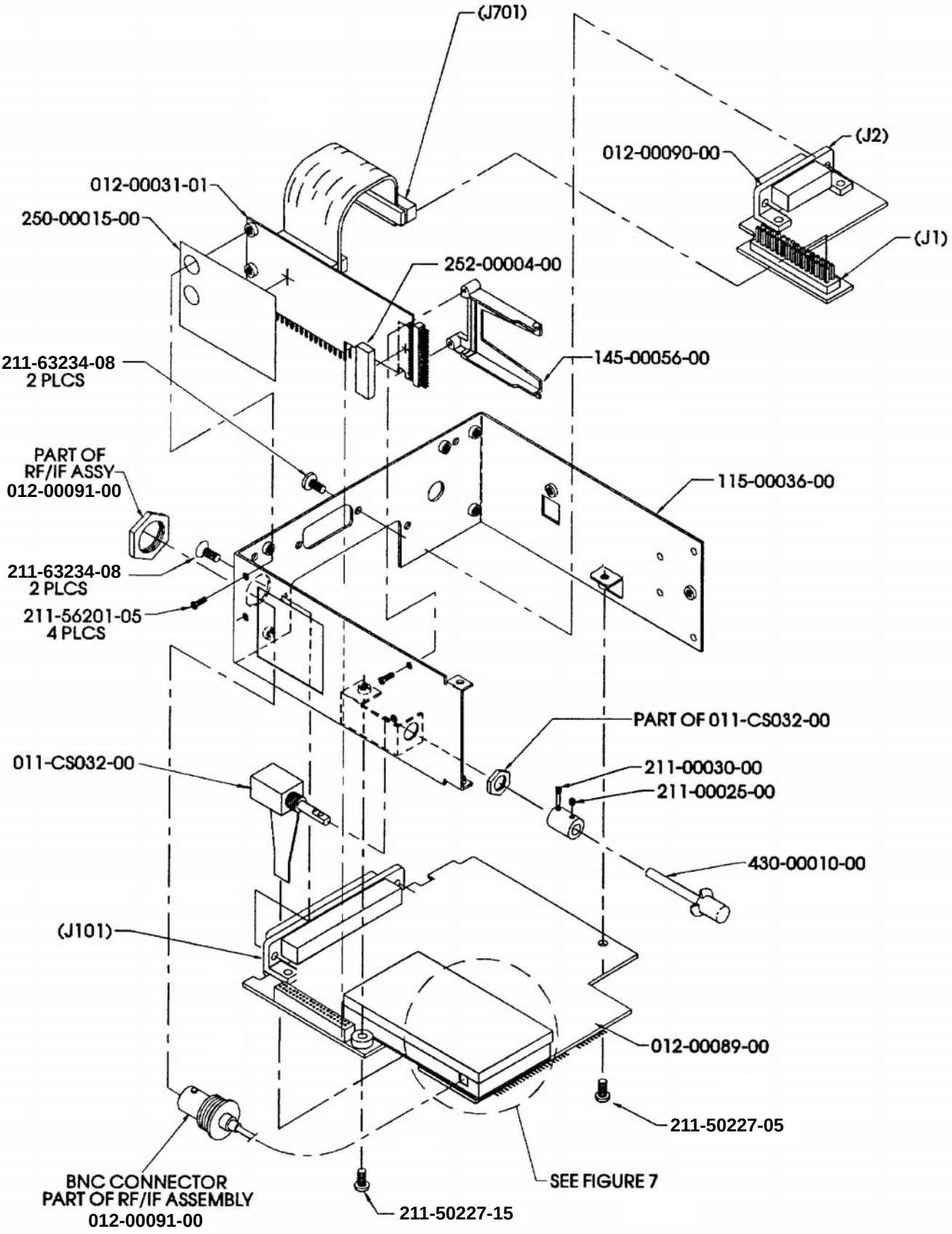


Figure 13
GPS 155 Assembly Drawing (View 2)

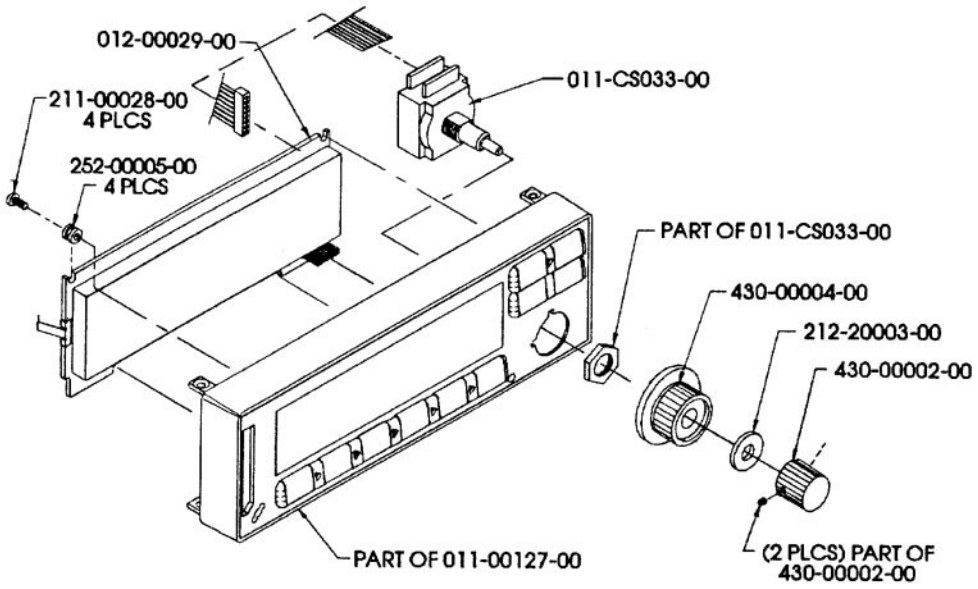
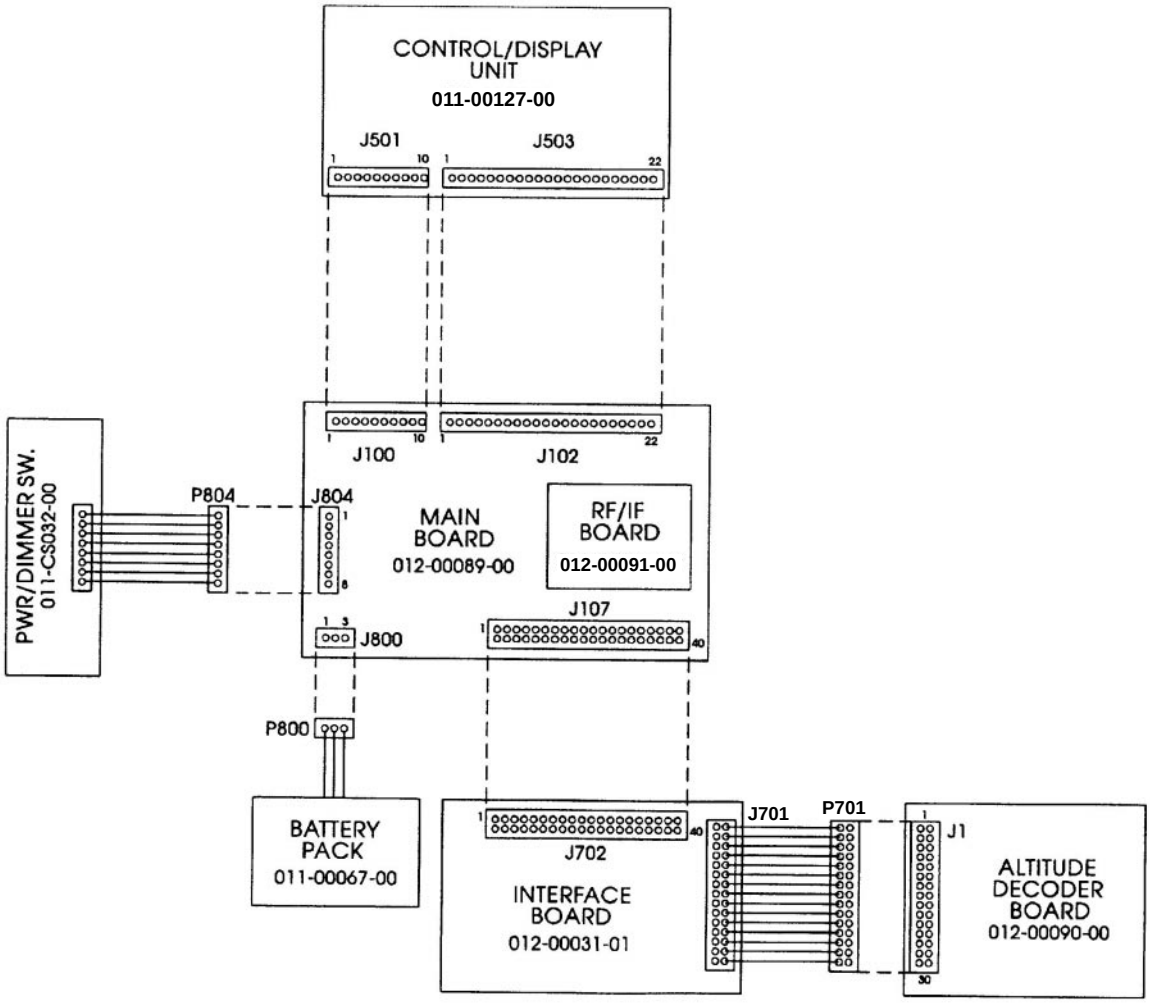


Figure 14
GPS 155 Assembly Drawing (View 3)

Figure 15



GPS 155 Connector Diagram